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ABSTRACT

This paper describes a 1-year study of 120 fifth-grade students whose teachers participated in a program entitled Project SMILE (Science and Math Integrated with Literary Experiences). The purpose of the study was to determine the extent to which the classroom implementation of Project SMILE positively influenced the classroom environment and student attitudes toward reading, writing, and mathematics. This was accomplished by, first, facilitating a series of five professional development workshops with the teachers and, subsequently, asking these teachers to use the strategies with their students. Because the program on which SMILE was based, Creating Independence through Student-Owned Strategies (Project CRISS), had already proven to be successful nationwide for secondary students, this study focused on elementary school (K-5) students and their teachers. Six classes of fifth grade students participated, but only 120 of the original 180 completed all aspects of the study. Project SMILE proved successful with these students in terms of promoting positive attitudes toward mathematics and creating positive changes in classroom environment and in using children's literature to empower students to learn mathematical concepts. (Contains 2 figures, 5 tables, and 34 references.) (SLD)

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# Evaluation of a K-5 Mathematics Program Which Integrates Children's Literature: Classroom Environment, Achievement and Attitudes

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Deborah V. Mink and Barry Fraser

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# Evaluation of a K-5 Mathematics Program which Integrates Children's Literature: Classroom Environment, Achievement and Attitudes

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This paper describes a one-year study of 120 fifth grade students whose teachers participated in a program entitled Project SMILE (Science and Math Integrated with Literary Experiences). The purpose of the study was to determine the extent to which the classroom implementation of Project SMILE positively influenced the classroom environment and student attitudes toward reading, writing and mathematics. This was accomplished by, first, facilitating a series of five professional development workshops with the teachers and, subsequently, asking these teachers to use the strategies with their students. Because Project CRISS, the foundation of SMILE, had already proven to be successful nationwide for secondary students, this study focused on elementary school (K-5) students and their teachers. This study is based on the evaluation of this unique program that integrates children's literature and mathematics as it relates to the study of learning environments. The research represents one of the relatively few studies that have employed learning environment dimensions as criteria of effectiveness in the evaluation of educational innovations (Maor & Fraser, 1996). Project SMILE proved successful with students in the elementary (K-5) program in terms of promoting students' positive attitudes toward mathematics and creating positive changes in classroom environment as well as using children's literature to empower students to learn mathematical concepts.

## 1.0 Introduction

In mathematics education, what to teach and effective ways to teach the content have become more publicly and hotly debated in some areas of the United States in recent years (Kennedy & Tipps, 2000). Teachers and parents are challenged to think about mathematics very differently from the school mathematics which they experienced (Kennedy & Tipps, 2000). The demands of the new century require that all children acquire an understanding of concepts, proficiency in skills, and a positive attitude toward mathematics in order to be successful (Kennedy & Tipps, 2000). According to the traditional view, students acquire mathematical skills by imitating demonstrations by the teacher and the textbook (Battista, 1999). As today's students learn mathematics skills and concepts, they must apply, adapt, and extend old concepts to new tasks and existing ideas into new ideas (Kennedy & Tipps, 2000).

In 1989, the National Council of Teachers of Mathematics (NCTM) took a decisive step toward improving the teaching of mathematics with the publication *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). This work represented a major effort to create a set of standards to guide the revision of the school mathematics curriculum and its associated evaluation (NCTM, 1989). The national standards are the basis for the district and state curricula in Miami-Dade County, Florida. Each mathematics lesson plan must reflect the district standards which are, in essence, the national standards.

*The Basics of School Improvement and Accountability in Florida GE356* (FDOE, 1997) changed the way in which mathematics is taught in the state of Florida. The change focused on a shift from rote acquisition of information to the understanding of

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underlying mathematical concepts. Mathematical ideas can be developed together through reading, writing, listening and discussing mathematics (Santa, 1984). To accomplish the goal of increasing students' mathematical learning, school districts investigated a variety of instructional programs. Project CRISS (Creating Independence through Student-owned Strategies), which began as a local experiment in Kalispell, Montana, is now being implemented in 43 states and three countries. In 1982, Kalispell was a state-validated CRISS demonstration site for Grades 10-12. The program was nationally validated in 1985. In 1993, the validation expanded to include grades 4–12. The National Diffusion Network (NDN) provided funding for CRISS from 1985 to1996, when NDN funding was eliminated by Congress (Santa, 1996). The NDN, part of the US Office of Educational Research and Improvement, provided validated projects with grant support for dissemination.

The project's basic underlying assumption is that poor student performance is due to the students' inability to read content area texts (Santa, 1996). CRISS strategies were designed to develop thoughtful and independent readers and learners. Project CRISS focuses on teaching secondary students how to learn content area subjects (mathematics, science and social studies) through reading, writing, speaking and listening. In its initial evaluation, students learned how to apply the CRISS principles to all subject areas (Santa, 1996). The following nine key principles drawn from cognitive and social learning research lay the foundation for Project CRISS (Santa,1996, p. 1).

- Background knowledge is a powerful determinant of reading comprehension.
- Good readers are actively involved in making sense from their reading.
- Students need many opportunities to talk with one another about what they are learning.
- Good readers use metacognitive strategies to learn. They are goal directed and they know how to attack print to create meaning.
- Students need many opportunities to write about what they are learning.
- Good readers and writers have an intuitive understanding of the author's craft. (Students understand the author's style of writing.)
- Good readers know a variety of ways to organize information for learning.
- Students learn to become strategic learners when given opportunities by teachers through explanation and modeling.
- Students come to understand by doing a variety of thought-demanding activities with a topic.

Project CRISS was adopted in Miami-Dade County at the beginning of the 1997-1998 school year.

Because Project CRISS had already proven successful with secondary students, the purpose of our study was to evaluate SMILE in terms of whether it positively influenced the classroom environment and student attitudes at the elementary school (K-5) level. This was accomplished by, firstly, facilitating a series of five professional development workshops with the teachers and, subsequently, asking these teachers to use

the strategies with their students.

This research was significant in several ways. Little research had been done on the strengths and weaknesses of the integration of mathematics and children's literature. Secondly, it was important to investigate if SMILE might prove successful with elementary school students because Project CRISS had been shown effective with secondary students.

The evaluation included two types of variables, namely, attitude and classroom environment. Our research involved the subject of mathematics, which has been the focus for relatively few past classroom environment studies. The research represents one of few studies that have employed learning environment dimensions as criteria of effectiveness in the evaluation of educational innovations (Maor & Fraser, 1996).

## 2.0 Background

### 2.1 Adaptation of CRISS

In 1998, the educational specialists assigned to the mathematics and science department were part of an intensive inservice training program for Project CRISS. These specialists were then able to begin training classroom teachers in the principles and strategies of Project CRISS. We felt that these principles and strategies would be of as much value to elementary (K-5) teachers as they are to secondary teachers. Research shows that exemplary teachers utilize strategies which encourage students to participate actively in learning activities (Fraser & Walberg, 1991, p. 287). Because the background of educational specialists is in teaching elementary school mathematics using a hands-on, conceptual approach, the principles and strategies of CRISS seemed a perfect match for the elementary school setting. As a result, we were inspired to adapt the program for elementary (K-5) teachers and to rewrite many of the activities presented in the CRISS Manual using popular children's literature. It was our hope that, after teachers use the CRISS strategies incorporating hands-on activities into their teaching, students would be better able to conceptualize mathematics.

In 1999, we began adapting the CRISS materials for the elementary school and renamed the project SMILE (Science and Mathematics Integrated with Literary Experiences). SMILE focuses on teaching students reading, writing and mathematics through an integrated literature and activity-based (hands-on) mathematics program.

In May 1999, the Florida Department of Education declared Project CRISS the number one program for helping to improve performance-based standardized test scores at the secondary school level (FDOE, 1999). Hopefully, SMILE will one day be on the same list of successful elementary (K-5) mathematics programs. Given the success of CRISS and the potential of SMILE, it was important to undertake this evaluation of its effectiveness.

The SMILE teacher' s manual was designed to infuse the principles and strategies of CRISS, and the national mathematics standards, into each lesson plan. The SMILE manual consists of five thematic units which are presented to teachers during a five-day training session. Each unit focuses on one or more of the following foundational ideas in the NCTM standards: Number Sense and Operations, Measurement, Geometry, Data Analysis and Algebraic Thinking. Each unit spirals into the next and each contains built-in reviews and extension activities.

The first unit is entitled *The Greedy Triangle Meets the Attribute Block.* Organizational tools, including Venn diagrams, and critical thinking activities are infused into the objectives identified in the NCTM (National Council of Teachers of Mathematics) geometry content strand. Marilyn Burns' *The Greedy Triangle* serves as the literary context for children to learn how to differentiate between the attributes of geometric shapes. Students investigate what happens to a geometric shape when sides and angles are added to a polygon. Attribute blocks are used to illustrate the concepts.

The second unit, *Structures in Math, Science and Architecture,* addresses the NCTM content strand of Number Sense and Operations. The underlying concepts behind computation are taught through the use of linking cubes, color tiles and base-ten blocks. The students learn that each operational symbol has meaning. For example, the symbol for addition is the plus sign, which can represent the word 'combine' among other meanings. All four basic mathematical operations are discussed and conceptualized in this same manner.

The content strand of geometry is taught using *The Greedy Triangle*. In the story, the character of the Greedy Triangle adds one more side and one more angle each time that he becomes unhappy. Using eight basic two-dimensional polygons, the teachers investigate this principle by constructing geometric figures with straws. The culminating activity is the construction of a three-dimensional dodecahedron from 12 two-dimensional pentagons.

The third unit, *Rainbows and Fish*, uses *The Rainbow Fish* by Marcus Phister. This unit focuses on the NCTM content strand of Number Sense and Operations. Addition and subtraction of fractions are taught using the strategy of *cross multiplication.* Children learn least common multiple, greatest common factor and fraction reduction using an Asian strategy called the ***ski-slope method***, as illustrated below:

14/20 = 7/10 2 /14 20

GCF = 2 7 10

LCM = 140

The numerator and denominator are divided by the smallest prime number that goes into both of them. The Greatest Common Factor is found by multiplying all of the numbers to the left of the slope. The Least Common Multiple is found by multiplying all

the way around the *slope* and the *ski*. The numbers under the *ski* are the original fraction's lowest terms.

Children explore geometric transformations by making a fish out of crackers. Students review Venn diagrams by discussing the attributes of the Rainbow Fish and the Greedy Triangle characters.

*Bug Out on Math and Science,* the fourth unit, deals with the NCTM content strands of Geometry, Data Analysis and Measurement. The focus of the unit is identifying angles, two- and three- dimensional objects, analyzing and collecting data, estimation and elapsed time. Students learn statistical vocabulary such as 'mean', 'median' and 'mode' through a trivia game. *The Hungry Caterpillar* and *The Grouchy Lady Bug,* both by Eric Carle, serve as the children's literature connections. These activities incorporate calculators to illustrate their importance in critical thinking.

The final unit in the SMILE manual incorporates all previously used CRISS principles and strategies as well as the NCTM content strands of Number Sense and Operations, Measurement, Geometry, Data Analysis and Algebraic Thinking. The teachers learn how to take any children's literature book and infuse all the principles and strategies of SMILE/CRISS. This final unit, *Math and Science for Chocolate Lovers,* addresses algebraic thinking using patterns of Hershey 'Kisses', single and double bar graphs using Hershey Miniatures, and probability and statistics using M & Ms. The book, *Chocolate by Hershey* by Betty Burford, provides the literature connection for the unit. This biography of Milton S. Hershey is also used to teach the importance of mathematics vocabulary.

## 2.2 Field of Classroom Environment

Our study drew on the field of classroom environment research (Fraser, 1994, 1998a). Also our research into learning environments is consistent with a long-standing tradition in the field of obtaining quantitative information through the administration of established questionnaires which assess students' perceptions of their classroom learning environment (Fraser, 1998b). Following recommendations made by Tobin and Fraser (1998), we also collected qualitative information based on observations and interviews and the interpretive techniques suggested by Erickson (1998).

One potentially useful application of classroom environment assessments which has been taken up surprisingly seldom in past research involves using classroom environment dimensions as dependent variables in evaluating educational innovations (see Dryden & Fraser, 1998; Maor & Fraser, 1996). Our study is noteworthy because it used classroom environment variables as process criteria of effectiveness in evaluating CRISS. Also, we followed the research tradition of investigating associations between student-perceived classroom environments and students' achievement and attitudinal outcomes (McRobbie & Fraser, 1993).

This study also is distinctive in that it adds to the small number of recent learning environment studies (e.g. Goh, Young & Fraser 1995; Majeed, Aldridge & Fraser, 2001) that focused on the school subject of mathematics.

## 3.0 The Study

### 3.1 Stages of the Study

Our study consisted of the four stages described below.

Stage 1 - Pretesting. An attitude questionnaire, based on the 1988 NAEP (National Assessment of Educational Progress) attitude survey, was administered to all students and teachers in the sample as a pretest. Also 10% of the students and teachers were interviewed regarding their responses to the attitude survey.

Stage 2 - Professional Development. SMILE inservice courses began for the designated teachers. These inservice courses were for five full days during a 10-week period. At the conclusion of each inservice day, the participants were asked to use the lessons and materials with their students and to return with student work samples the following time.

Stage 3 - Pretest of Classroom Environment. The students responded to a classroom environment survey as a pretest after the first day of the teachers' professional development activities. The *My Class Inventory* (MCI) (Fraser & O'Brien, 1985) was chosen for many reasons. The reliability of the MCI had been established in several previous research programs. The MCI assesses five classroom environment dimensions (Satisfaction, Friction, Competitiveness, Difficulty, and Cohesiveness) that seem relevant to the present study. The MCI has a simple two-point response format (Yes and No) and is easy to administer. Importantly, the readability of the questions allows them to be understood by students with only basic reading abilities.

Data collected during the 1997-1998 school year revealed that 58% of the students in M-DCPS were language deficient in that English is not their home language (*MDCPS Statistical Abstract 1997-1998).* Therefore, we felt that the vocabulary in the MCI and the NAEP attitude survey were appropriate for the sample of students. Ten percent of students responding to the MCI were interviewed about their responses.

Stage 4 – Attitude and Classroom Environment Posttest. The attitude survey and classroom environment inventory were readministered to the teachers and students in the sample at the completion of the professional development program. The mandatory teacher evaluations used by Miami-Dade County's Teacher Education Center and Project CRISS were also administered to the teachers and used as qualitative data.

### 3.2 The Sample

The sample covered mathematics classes at the elementary school (K-5) level. The teachers and students were selected to represent the diverse group of teachers and students found in the Miami-Dade County Public Schools. The teachers, designated by

the school principal to attend the SMILE workshop, were asked to participate in the research. Preference was given to teachers who teach Grade 5. A sample of six teachers from two schools was involved. With each teacher having over 30 students in his/her class, the sample size approached 200 students. After all results were collated, there were 120 students who had completed all surveys, inventories and achievement tests, and this reduced sample without any missing data was used for statistical analyses. Six classrooms of Grade 5 students participated in the SMILE pilot study.

Our evaluation of SMILE began during the 2000-2001 school year. The goal in using SMILE was to improve the teaching and learning of mathematics by integrating mathematics with children's literature and the principles and strategies of CRISS. From the first pilot group of 30 teachers, six teachers were asked to implement SMILE. These teachers were from Tulip and Daniel Elementary Schools. The students in these schools had received similar initial scores on the FCAT. From the original sample of 180 students, only 120 Grade 5 students completed all aspects of the study.

Tulip Elementary.

Tulip Elementary School is in a lower-income, African-American neighborhood. Ninety-eight percent of the students in this school are on free lunch (OEEMA, 2000) which the Federal government provides for students from low-income households. Tulip received a 'D' in Florida's school improvement plan. It did not meet the passing criteria in reading or mathematics. One of the teachers from this school had been in the SMILE pilot project during the year before. The students in her classroom showed a 10-point gain on the Stanford Achievement Test – ninth edition (SAT 9$^{th}$ edition) (OMEEA, 1999). Because of this gain, the Principal wanted all the teachers in the school to be involved in the project. He also allowed the use of the school as the site for the professional development workshops.

Daniel Elementary.

Daniel Elementary School is in a middle-class, multi-ethnic community. Two fifth grade mathematics teachers volunteered to be involved in the study. The Principal offered her school as a site for the professional development as well. This school received a 'C' in Florida's A+ School Plan (FDOE, 1997).

Six hundred dollars worth of materials and supplies were given to each teacher-participant in the professional development inservices of SMILE. The funds for the materials and supplies come from The Title II Eisenhower Professional Development Program. This federally-funded grant program focuses on the professional development of teachers in mathematics and science.

For the interview portion of the study, parental permission was obtained for the students involved. The Principals also gave permission for the students and teachers in their schools to be involved from the inception of the project. At both schools, the Principals requested that the schools be used as a pilot site in the study and offered to be the site for district-wide professional development. The schools' and students' names are not reported and any specific references to schools makes use pseudonyms.

### 3.4 Data Collection

A range of quantitative and qualitative data were collected relevant to this evaluation. Quantitative data were gathered from three sources. First, an adaptation of the 1988 NAEP (National Assessment of Educational Progress) attitude inventory provided a measure of changes in student attitudes to reading, writing and mathematics. Second, Fraser and Fisher's (1985) My Class Inventory was to provided a measure of student perceptions of their classroom learning environment. Qualitative data were gathered from six classroom observations, student and teacher interviews that were recorded and transcribed, and student work samples that were collected by each teacher. We hypothesized that the program would promote positive attitudes toward the learning of mathematics, and improved student perceptions of classroom environment. A particular focus was the effectiveness of the program across gender, ethnic backgrounds and socio-economic levels.

### 3.5 Attitude Survey

An attitude survey, based on the 1988 NAEP attitude survey, was administered to the six classes of fifth grade students. This survey dealt with student and teacher attitudes toward reading, writing and mathematics. The original NAEP survey was adapted for elementary students and validated by Dr Okhee Lee for the Math and Science Resource Teacher Program of the University of Miami (Miami, 1991). The pretest and posttest surveys were administered to both the teachers and students involved in the study. The teachers and students responded to the survey on the first day of the inservice workshop. The teachers responded to nearly the same survey as the students. For example, the students answered the question "Do you like mathematics?", whereas the teachers answered the question, "Do you like TEACHING mathematics?"

### 3.6 Classroom Environment Instrument

We chose the My Class Inventory (MCI) as a measure of classroom environment (Fraser & Fisher, 1983). All of the students in the study completed the inventory. We chose this particular instrument because the vocabulary is well suited for the elementary school child, the responses are in a simple Yes-No format, and the answers are recorded on the questionnaire itself to avoid errors in transferring information from one place to another (Fraser, 1989).

The MCI is a one-page questionnaire that measures five dimensions, yet contains only 25 questions (Fraser, 1989). These dimensions are *Satisfaction, Friction, Competitiveness, Difficulty* and *Cohesiveness.* These scales also measure student perceptions of *actual* and *preferred* classroom environment. The *preferred* form is concerned with goals and value orientations as it measures perceptions of the environment ideally liked or preferred. (Fraser, 1989) The *actual* form measures perceptions of the environment that are really happening in the classroom. Both forms were read aloud to the students in their own class setting.

## 4.0 Bases of Quantitative Information

### 4.1 Reliability and Validity of Attitude and Environment Scales

The first research question is as follows:

> What is the reliability and validity of the attitude and learning environment scales used with the sample elementary mathematics students?

The attitude instrument used in the present study consists of five items that assess each of Attitude to Reading, Attitude to Writing and Attitude to Mathematics. These items were based on a NAEP Attitude Survey (1988). These 15 attitude items were administered both as a pretest and as a posttest to the sample of 120 elementary school students whose teachers were teaching the SMILE program.

Table 1 provides, for each attitude scale, an estimate of scale internal consistency (the extent to which items in the same scale measure a common construct) and discriminant validity (the extent to which a scale measures a unique dimension not assessed by another scale). Whereas internal consistency was assessed using Cronbach's alpha reliability coefficient, discriminant validity was assessed using the correlation of a scale with the other scales ad a convenient index. Data were analyzed separately for pretest and posttest responses. Results are reported in Table 1.

TABLE 1. Internal Consistency (Cronbach Alpha Reliability Coefficient) and Discriminant Validity (Correlation with Other Scales) for Attitude Scales at Pretest and Posttest

| Scale | No. of Items | Form | Alpha Reliability | Correlation | |
|---|---|---|---|---|---|
| | | | | Writing | Mathematics |
| Attitude to Reading | 4[a] | Pre | 0.54 | 0.00 | 0.74 |
| | | Post | 0.42 | -0.18 | -0.14 |
| Attitude to Writing | 5 | Pre | 0.64 | | 0.00 |
| | | Post | 0.50 | | 0.40 |
| Attitude to Mathematics | 5 | Pre | 0.51 | | |
| | | Post | 0.60 | | |

The sample consisted of 120 students.
[a] Item 5 omitted.

When Item 5 was omitted from the Attitude to Reading scale, the alpha reliability coefficient rose from 0.51 to 0.64 for the pretest and from 0.42 to 0.60 for the posttest (Table 1). Although the reliability values in Table 1 are relatively low, they provide adequate support for the reliability of short attitude scales containing only four or five items each.

Table 1 shows too that, for most cases, the correlation of an attitude scale with the other two attitude scales is relatively small with the exception of Attitude to Reading with

Attitude to Mathematics. This suggests that the three attitude scales are relatively independent of each other.

In terms of the reliability and validity of the MCI, the same two indices of internal consistency and discriminant validity are reported in Table 2 separately for the actual and preferred forms for the sample of 120 students. Alpha coefficients range from 0.51 to 0.77 for the actual form and from 0.51 to 0.89 for the preferred form. As a convenient index of discriminant validity, use was made of the mean correlation of a scale with the other four MCI scales. Discriminant validity indexes range form 0.15 to 0.28 for the actual form and from 0.06 to 0.47 for the preferred form. Overall, the data in Table 2 suggests that both the actual and preferred forms of MCI scales display adequate internal consistency and discriminant validity.

TABLE 2. Internal Consistency Reliability (Cronbach Alpha Reliability Coefficient), Discriminant Validity (Mean Correlation With Other Scales) and ANOVA Results for Ability to Differentiate Between Classrooms for Actual and Preferred Form of each MCI scale

| MCI Scale | No. of Items | Form | Alpha Reliability | Mean Correlation | ANOVA $Eta^2$ |
|---|---|---|---|---|---|
| Satisfaction | 5 | Actual | 0.67 | 0.28 | 0.15** |
| | | Preferred | 0.70 | 0.46 | |
| Friction | 5 | Actual | 0.68 | 0.20 | 0.12** |
| | | Preferred | 0.70 | 0.46 | |
| Competitiveness | 5 | Actual | 0.64 | 0.25 | 0.06 |
| | | Preferred | 0.74 | 0.42 | |
| Difficulty | 4* | Actual | 0.51 | 0.15 | 0.13** |
| | | Preferred | 0.51 | 0.06 | |
| Cohesiveness | 5 | Actual | 0.77 | 0.20 | 0.08* |
| | | Preferred | 0.89 | 0.47 | |

** $p<0.01$ * $p<0.05$

One item was omitted from the Difficulty scale.

The last column of figures in Table 2 provides evidence about whether the actual form of each scale is capable of differentiating between the perceptions of students in different classes. Ideally, students within the same class should perceive its environment relatively similarly, whereas mean class perceptions should vary from class to class. This characteristic was explored for each MCI scale by performing a one-way ANOVA with class membership as the main effect. Table 2 shows that all scales except Competitiveness were able to differentiate between classes. The $eta^2$ statistic, which represents the proportion of variance in an MCI scale accounted for by class membership, ranges from 0.06 for Competitiveness to 0.15 for Satisfaction.

## 4.2 Changes in Student Attitudes

The second research question reads as follows:

> After the teachers participate in the professional development activities for Project SMILE, were there changes in the attitudes of students regarding reading, writing and mathematics?

Table 3 shows the average item mean, the average item standard deviation, and the effect size and the *t* test for the paired samples for differences between pretest and posttest scores on each of the attitude scales for individual students. The average item mean (i.e. the scale mean divided by the number of items in a scale) was used to provide a meaningful basis for comparing the means of scales containing differing numbers of items.

TABLE 3. Average Item Mean, Average Item Standard Deviation and Difference Between Pretest and Posttest Scores(Effect Size and *t* Test for Paired Samples) for Attitude Scales for the Individual as the Unit of Analysis

| Attitude Scale | Average Item Mean | | Average Item Standard Deviation | | Difference | |
|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Effect Size | *t* |
| Attitude to Reading | 2.64 | 2.54 | 0.41 | 0.52 | 0.22 | -1.69 |
| Attitude to Writing | 2.52 | 2.75 | 0.48 | 0.33 | 0.57 | 5.34** |
| Attitude to Mathematics | 2.39 | 2.68 | 0.48 | 0.43 | 0.64 | 4.97** |

N=120 students
** <0.01

There were statistically significant differences in student attitudes toward both writing and mathematics between pretest and posttest (Table 3). Attitude toward writing improved in its average item mean score from 2.52 to 2.75 (or an effect size of 0.57 standard deviations). Attitude toward mathematics changed from 2.39 to 2.68 (an effect size of 0.64). Attitude toward reading did not show a statistically significant change between pretest and posttest. The effect sizes for the statistically significant changes suggest that the magnitudes of pre-post changes are educationally important.

Figure 1. provides a graphical representation of the means in Table 3 for the attitude scales.

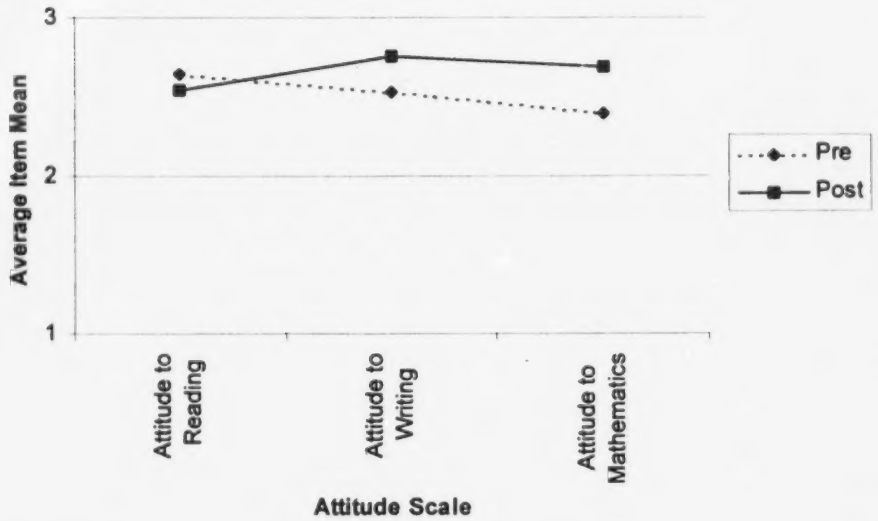


FIGURE 1. Changes in Student Attitudes Between Pretest and Posttest

This figure illustrates how there was an improvement in attitudes to mathematics and writing between pretest to posttest. However, there was a small and statistically nonsignificant decline in student attitudes toward reading between pretest and posttest.

4.3 Describing and Comparing Actual and Preferred Learning Environments

The third research question is listed below:

> What difference, if any, exist between compare students' perceptions of actual and preferred learning environment?

Table 4 reports the average item mean for the actual and preferred forms of each MCI scale together with the average item standard deviation and the difference between actual and preferred scores on each scale (effect size and results of a *t* test for paired samples). Mean scores also are graphed in Figure 2.

TABLE 4. Average Item Mean, Average Item Standard Deviation, and Differences Between Actual and Preferred Scores (Effect Size and *t* Test for Paired Samples) on each MCI Scale

| MCI Scale | Average Item Mean | | Average Item Standard Deviation | | Difference | |
|---|---|---|---|---|---|---|
| | Actual | Preferred | Actual | Preferred | Effect Size | *t* |
| Satisfaction | 2.66 | 2.67 | 0.30 | 0.15 | 0.24 | 0.11 |
| Friction | 2.43 | 2.19 | 0.28 | 0.26 | 0.89 | -8.07** |
| Competition | 2.61 | 2.34 | 0.30 | 0.33 | 0.86 | -8.08** |
| Difficulty | 2.14 | 2.23 | 0.22 | 0.49 | 0.27 | 1.68 |
| Cohesiveness | 2.39 | 2.61 | 0.33 | 0.25 | 0.76 | 8.16** |

Table 4 shows that students prefer a significantly more favorable classroom environment on the three scales of Friction, Competition and Cohesiveness. That is, students prefer less Friction, less Competition and more Cohesiveness. Effect sizes exceed three quarters of a standard deviation for these three scales. For the other two MCI scales of Satisfaction and Difficulty, differences between actual and preferred scores were statistically nonsignificant. This pattern, in which students prefer a more positive learning environment than the one perceived to be actually present, replicates prior research in other countries (Fisher & Fraser, 1983; Fraser, 1998a). In terms of evaluating the effectiveness of SMILE teachers in creating positive learning environments, it appears that the levels of classroom Satisfaction that are actually created by these teachers are very similar to the levels preferred by the students. However, relative to student preferences, the actual environment of the SMILE teachers' classrooms is perceived to have too much Friction and Competition and too little Cohesiveness.

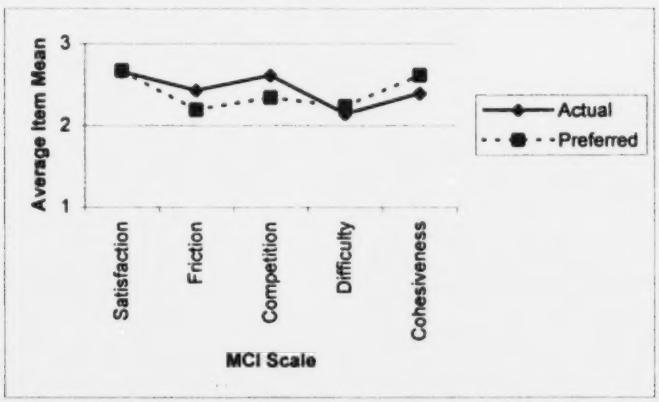


FIGURE 2. Average Item Mean for the Actual and Preferred Forms of MCI

## 4.4 Associations Between Attitudes and Learning Environment

The fourth research question is:

> Is there a relationship between students' perceptions of classroom environment and their attitudes toward reading, writing and mathematics?

TABLE 5. Simple Correlation and Multiple Regression Analyses for Associations Between Satisfaction, Attitudes and Four MCI Scales

| | Outcome – Environment Association | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MCI Scale | Satisfaction | | Attitude to Reading | | Attitude to Writing | | Attitude to Mathematics | |
| | r | *B* | r | *B* | r | *B* | r | *B* |
| Friction | -0.23* | -0.10 | -0.15 | -0.15 | 0.02 | -0.15 | -0.13 | -0.02 |
| Competition | -0.21* | -0.06 | 0.01 | 0.11 | 0.07 | 0.01 | 0.10 | 0.01 |
| Difficulty | -0.18* | -0.15 | 0.08 | 0.00 | -0.05 | 0.06 | 0.04 | -0.07 |
| Cohesiveness | 0.50** | 0.44** | -0.00 | -0.03 | -0.08 | -0.05 | -0.01 | -0.08 |
| Multiple Correlation (*R*) | | 0.53** | | 0.17 | | 0.16 | | 0.12 |

*$p<0.05$ **$p<0.01$
N= 120 students.

Table 5 reports associations between students' attitudinal outcomes ( namely, Satisfaction from the MCI and the three scales assessing attitudes to reading, writing and mathematics) and students' perceptions on the other four learning environment scales of the MCI (Friction, Competition, Difficulty and Cohesiveness). It should be noted that, for the purposes of these analyses, the Satisfaction scale from the MCI was conceptualized and used as a dependent variable.

The simple correlation analysis provides information absent the bivariate relationship between each attitude outcome and each classroom environment scale. The multiple correlation describes the joint relationship between each attitude outcome and the set of four classroom environment scales. The regression coefficient describes the association between an attitude scale and a particular environment scale when the other three environment scales are mutually are controlled.

Table 5 shows that there are no statistically significant associations between classroom environment and attitudes to reading, writing or mathematics. However, student Satisfaction is statistically significantly correlated with all four learning environment scales. However, the multiple correlation between Satisfaction and the environment scales is 0.53 and is statistically significant. The regression coefficients show that Cohesiveness is a significant independent predictor of student Satisfaction when the other environment scales are mutually controlled.

Overall, the results in Table 5 suggest that student Satisfaction is higher in classes that have a more favorable classroom environment in terms of less Friction, Competition and Difficulty are more Cohesive. However, Cohesiveness is the strongest predictor of student Satisfaction.

## 5.0 From Qualitative Investigation

Six students and six teachers were interviewed privately using the NAEP Attitude Survey as a basis for designing interview questions. The questions were read and their responses were recorded and transcribed. The teachers collected student work samples as proof that the teachers were implementing the program in their classrooms.

Findings based on qualitative information are summarized in the following sections using case study methods.

In particular, the following case study is that of Mrs Tanya Robinette and her student, Barbara. Tanya teaches at Daniel Elementary and Barbara is in her homeroom class. In the sections below, we use "I" to refer to the first author of this paper.

### 5.1 Why Tanya Robinette was Chosen

Upon the request of the Principal, I visited Daniel Elementary three times to help the faculty textbook committee select a new mathematics textbook. Tanya was a member of the textbook adoption committee. After viewing the 13 state-adopted textbooks, the Principal, Tanya and I were convinced that the research-based textbook would be the perfect book to implement. After I finished writing SMILE, I asked Tanya if I could use the children in her classroom to test some of my lessons. She agreed. She attended the first series of SMILE workshops.

Tanya Robinette teaches 5$^{th}$ grade mathematics at Daniel Elementary School located in a large, urban school district in the Southeast of the USA. The district has the highest percentage of Spanish and Haitian-Creole Limited English Proficient (LEP) students in the state. This is Tanya's 26$^{th}$ year of teaching. She has been at Daniel for her entire teaching career. For the past two years, the school used a research-based mathematics program from the University of Chicago. That is not the sole program that Tanya uses. Experience has taught her that there is good in any program. She finds new lessons and strategies and uses them when teaching children. She attends at least two mathematics workshops per school year. She says that she is always looking for "the program" to implement so that she won't have to write every lesson herself.

Tanya is not bilingual. When she began teaching at Daniel, this did not pose a problem, but now it is necessary for a translator to be present during parent conferences. Nearly half the parents do not speak English. She is also finding that children are bringing in other strategies for learning mathematics from their home countries. Tanya used to say: "My way is the right way and it's the only way." Now, she is learning other strategies to help her children.

We interviewed the teachers and students before and after the inservice program. We also modeled three lessons in each classroom. Each person was privately interviewed in the school setting. We took notes and tape-recorded each interview.

5.2 Tanya Talks about her Class

Tanya does not like to teach reading or writing, and nor does she feel that she is good at teaching reading and writing. She thinks that, if she tried, she **could** teach reading and writing well, but she has always loved teaching mathematics. She thinks that teaching writing is boring and difficult. When the Principal asked her if she would like to departmentalize the fifth grade, she was thrilled. The students have been departmentalized for the past three years. She now teaches mathematics to one half of the students at Daniel and teaches lessons to the entire grade level once a week.

Tanya loves to teach mathematics and is good at teaching it. She believes that everyone can teach mathematics well if they try. Teaching mathematics is not boring or hard. She uses the required mathematics textbook as a reference. She is required to use the assessments from the research-based mathematics textbook. She said that it is difficult for some veteran teachers to use the new text, but she found it challenging and fun to teach. She felt that this text exemplifies the way in which mathematics should be taught. She did caution that she did not teach the textbook page by page. She uses the textbook about half of the time. For the rest of the lessons, she teaches material from a variety of other good programs.

Tanya's classroom is aesthetically pleasing. She has mathematics-related bulletin boards, the manipulatives are easily accessible, children's' work is displayed and the children are engaged in learning activities. The 42 desks are in straight rows. I suggested that Tanya move the children into groups. She declined at this point because she said that this was the beginning of the year and that all of the children did not have self-control. I observed Tanya teaching a lesson on the addition of fractions with unlike denominators. She demonstrated how to solve the algorithm procedurally. The children looked perplexed. Eleven of the children raised their hands for help. Using the blackboard, Tanya solved example after example in this same manner. One child asked if there was another way to do the problem. Tanya responded: "No, this is the only way. You must learn it this way because it is on the test." After doing 20 examples at the board, she gave the children a written assignment. "Open your books to page 221 and do numbers 1 to 25." The children all opened their books. They all attempted to do the first problem. Some of the children attempted to complete the assignment, while others called "Mrs Robinette" over and over again seeking help. Tanya walked around helping individual students. Most of the children did not understand how to begin, much less complete, the assignment.

5.3 How I met Barbara

On my first day of observing, Tanya introduced me to the class. She explained that I was doing research and that I would be observing and teaching the class throughout the semester. The minute that Tanya was finished introducing me, a girl ran up to me, gave me a big hug and said: "My name is Barbara and I hate mathematics." She also said that she was the only one in the class that had a 'D'. The teacher later verified that fact. Barbara walked back to her seat in the back of the room and seemed to listen to Tanya attentively during the lesson. Upon receiving the assignment, Barbara immediately put her head down. I walked over to her and asked if I could help. She said: "I can't do this

because I am the dumbest one in the class." I knew, at this point, that Barbara would be the subject in my case study.

Barbara, a fifth grade student at Daniel Elementary School, was excited about being interviewed. At the onset of the interview, she again told me how much she hated mathematics and how dumb she was in mathematics. I started the interview. She told me that she loves to read. She reads approximately seven books per week. She loves to read any kind of book. She believes that anyone can read well if they try. Reading is never boring to her and she says that, if reading is boring to other children, it is because they just don't want to read. Reading is not hard for Barbara. She usually gets a 'B'. She said that she gets a 'B' and not an 'A' because she doesn't turn in her written assignments.

Barbara also likes to write. She once wrote a story about ketchup falling in love. She thinks that she is good at writing. She also thinks that everyone can write well if they try. Writing is not boring for her and it is not hard. For fun at home, she writes stories on the computer. Her mother gave her a book of story starters and she loves to write and illustrate the stories on her computer.

Barbara has never liked mathematics. Because it was early in the year, she was not sure if she liked mathematics in fifth grade or not. She said that she had to find out how the teacher was before she could make up her mind. She remembers when she first started hating mathematics. It was in first grade. She said that, because she did not know her addition and subtraction facts, she was put in the "dumb class". Ever since then, she has hated mathematics, especially computation.

She thinks that she would like to do mathematics if she could relate it to things that she likes to do in real life --- like shopping!

After this initial observation day, the SMILE workshops began with Tanya Robinette in attendance.

### 5.4 Working at Daniel Elementary School

All fifth grade students at Daniel Elementary School spent one hour per week in a whole group lesson. These classes are held in the cafeteria. Tanya Robinette taught one new mathematics concept per week to 150 students. The children sat at cafeteria tables using only paper and pencil. Tanya taught the lesson using an overhead projector while the children took notes. Three teachers and three paraprofessionals (teacher aides) served as monitors to assist children. The children worked diligently throughout the one hour session. About every 10 minutes, Tanya would choose a child to come to the overhead projector and explain an answer to the rest. When Tanya was asked who decided to have these sessions, she told me that the teachers decided to do it this way because all the children would then get the same instruction on the most difficult topics of the FCAT. Because Tanya was the mathematics expert, she would teach the lessons and the other teachers would follow up. These classes were held weekly from the first week of school until the week before the administration of the FCAT.

I was disturbed because, if these were the most important concepts on the FCAT, why weren't they being taught using hands-on activities? I hoped that this would change after Tanya had completed the SMILE training.

5.5 Robinette's Concerns

After observing the group lesson, Tanya and I spoke privately. The use of manipulatives and children's literature are the main emphases of the SMILE workshops. Mrs Robinette expressed the desire to use manipulatives, but found the children to be too disruptive and out of control. This is also the reason why she had the children put their desks in straight rows. She was also afraid to use children's literature as an introduction to a mathematics lesson. She said that the children thought that these books are "baby books". We discussed this problem and I told her that, after I taught three lessons in her classroom, I hoped that she would feel more confident and try to incorporate these activity-based strategies into her daily lesson plans.

5.6 The Lessons

The first lesson that I taught, *Data Analysis for Chocolate Lovers*, introduced the children to mean, median, mode, theoretical and actual probability, and the relationship between circle and bar graphs. I used M & Ms to help to illustrate the concepts. The first thing that I asked the children to do was to move their desks into groups of four. They were told that they must work with this group, and there would be no exceptions. I gave the students markers, scissors and glue to use. The children seemed surprised that they would use these in mathematics class. I had to go over my rules for the use of these things.

I taught my lesson on *Mean, Median and Mode*. I read the story, *Mrs Mean, the Math Teacher* by Gretel Mink. This story was written by Gretel to help her to remember the definitions of mean, median and mode. After I read the story, the children played a chocolate trivia game. The children read facts about chocolate. They were asked to estimate the answers, analyze the responses and find the mean, median and mode of their set of numbers. We discussed the estimates and I gave the correct answers for this chocolate trivia.

The children were then given a cup of M & Ms to count and to make a bar graph of the frequencies of the different M & M colors. The bar graph is then turned into a circle graph. We then began to discuss theoretical and actual probability. The children experimented with replacement probability using 10 M & Ms. The children recorded 100 trials of drawing the candy from a cup, recording the color and placing the candy back in the cup for the next draw. The results were recorded and conclusions were drawn. We discussed the findings. This lesson took two hours for the students to complete. There was not one discipline problem. I administered a written assessment the following week. The scores ranged from 92% to 100%.

I watched Barbara throughout the lesson. She seemed confident that she could complete the lesson. As I monitored the progress of the lesson, I kept my eye on Barbara. She did not ask questions. Her group worked well together. She got 99% on her assessment. She brought her test to me to see.

5.7 Tanya's Perception

After watching me teach the first lesson, Tanya wanted to try to use manipulatives. She "forced" herself to use manipulatives to teach a lesson once a week. By the end of the year, she was using manipulatives at least two times per week. She had also been afraid to use a children's literature book as an introduction to a mathematics lesson. I introduced my third lesson with Eric Carle's *The Hungry Caterpillar*. Tanya saw how a primary (K-2) book could be used to teach higher-level mathematics. She saw how the children were engaged in the lesson. Not one child made 'a baby book' comment. She asked me to observe her teaching a lesson on the concept of elapsed time. She introduced the concept using Eric Carle's *The Grouchy Ladybug*. She said that I thought that the children would laugh at me when I read *The Grouchy Ladybug*, but then they realized that they would get to make their very own clock. I saw that they were actually learning something from 'the baby book'. Tanya was now ready to incorporate children's literature and manipulatives into every concept that she taught.

5.8 Barbara's Perspective

I taught three lessons to Barbara's class. At the end of a ten-week period of time, I asked Barbara the same questions about mathematics again. I asked her if she liked mathematics and she said: "Yes, when we do the mathematics books and activities that come after." When asked if she was good at mathematics, she said that, as long as she didn't have to do fast computation, she was pretty good. She was good at figuring out problems if she had to do so. She said that she could still see her first grade teacher yelling at her because she was dumb, but she knew now that she wasn't dumb in mathematics. Mathematics was no longer boring when I was there doing a lesson. She said that her teacher was doing more and more fun things instead of lecturing. I asked if she was still getting a 'D' in mathematics and she said that she was now getting a 'B'. I followed Barbara's progress throughout the rest of the year. Her mathematics grades for each quarter of the year were 'D', 'B', 'B', and 'A'. I visited Barbara during the last week of school. She came running up to me again. She said: "Thank you for not letting me be dumb in mathematics. You know, I still remember the M & M mathematics. I think my favorite subject in high school will be statistics." I said to myself: "Success". Barbara's FCAT score was a 'Level 4'.

5.9 Summary of Qualitative Research

I went back to Daniel at the end of the school year. The FCAT scores had just been announced. The school had gone from a 'C' to an 'A'. I asked Mrs Tanya Robinette the same questions that I had asked prior to the inservice program. She had a different attitude toward the teaching of reading and writing. She said that she would now like to teach reading and writing—but only through mathematics. She still thought that she would find it boring to teach reading and writing if she didn't integrate it into her mathematics, but that she would teach reading and writing if she was forced to do so. She said that, for next year, she would start using manipulatives for the group lessons. Her concern was that the fourth grade teachers didn't really concentrate on mathematics

because the children were tested only in writing and reading. They really didn't do much mathematics until *after* the FCAT was over at the end of March. She suggested to the Principal that all of the teachers take the SMILE inservice program during the next school year. I asked her if she thought that the SMILE inservice program was the main factor in raising test scores. She said that she thought that it was one of them. She said that: "Between SMILE, the new text, the group lessons and the departmentalization of the fifth grade, these all contributed to the achievement scores going up." She thought that the most significant changes were in student attitudes toward learning mathematics and the classroom environment. She said that these outcomes were much more significant to her than raising the achievement scores. She said that she was impressed that the children could work together in groups and had fun learning mathematics. She attributed this to her SMILE training. During the following year, all of the teachers at Daniel Elementary School took part in the SMILE inservice program.

Throughout the interviews with the students and teachers, there seemed to be one overall theme. In the words of Tanya Robinette, "I think the most significant changes were in students' attitudes toward learning mathematics and changes in the classroom environment".

All of the teachers who were interviewed were impressed by the fact that the children could work together in groups and had fun learning mathematics. This, to them, was more important than academic achievement. They stated that now, because the children could work together, they were ready to learn mathematics. This statement is supported by a study that found a direct association between positive student attitudes and improved classroom environments. Students achieve more when there is a positive classroom environment (Fraser, 1997).

**7.0 Conclusion**

The purpose of this research was to investigate if implementing SMILE positively influenced the classroom environment and student attitudes. Overall, our data provide strong support for the effectiveness of the innovative SMILE program. When pretest-posttest changes in students' attitudes and perceptions of classroom environment were analyzed, statistically significant differences and appreciable effect sizes were obtained for both attitudes and learning environment. Also, as in considerable prior research (e.g. McRobbie & Fraser, 1993), student satisfaction was found to be related to student-perceived learning environment.

Qualitative information supported the patterns of results from the questionnaires and enhanced our understanding of how Project SMILE operated to enhance students' classroom environment and attitudes toward reading, writing and mathematics.

The evaluation of SMILE has shown that using children's literature in the mathematics classroom empowers students to learn mathematical concepts. SMILE proved successful with elementary school students in terms of promoting students' positive attitudes toward mathematics and improving the classroom environment.

The results of the present study have implications for implementing SMILE districtwide. Consequently, there is a need for ongoing training and feedback from teachers and students. Research suggests that students achieve more when there is a positive classroom environment (Fraser, 1994); Fraser and Walberg (1991). Because the

findings of this study provide strong support for the effectiveness of SMILE only in terms of students' attitudes and their for increasing positive student perceptions of classroom environment, research is needed to evaluate the effectiveness of the SMILE on student academic achievement.

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